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Project Summary

External Combustion Particulate Emissions: Source Category Report

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The objective of this study was to develop particulate emission factors based on cutoff size for inhalable particles for external combustion sources. After a review of available information characterizing particulate emissions from external combustion sources, the data were summarized and rated in terms of reliability. Size specific emission factors were developed from these data for the major processes used in combustion. A detailed process description is presented with emphasis on those factors affecting the generation of emissions. A replacement for Sections 1.1 (Bituminous and Subbituminous Coal Combustion), 1.2 (Anthracite Coal Combustion), 1.3 (Fuel Oil Combustion), 1.4 (Natural Gas Combustion), 1.6 (Wood Waste Combustion in Boilers), and 1.7 (Lignite Combustion) of AP-42 was prepared, containing the size specific emission factors developed under this program.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The purpose of this program was to summarize the best available information on emissions of inhalable particulate matter for external combustion sources. The main objective of the program was to develop reliable size-specific emission factors for the various processes used in combustion. Both uncontrolled and controlled emission factors are presented in the report. The uncontrolled factors represent emissions which would result if the particulate control device (baghouse, scrubber, etc.) were bypassed, and the controlled factors represent emissions emanating from a particular type of control system. The size-specific emission factors are generally based on the results of simultaneous sampling at the inlet and outlet of the control device(s), utilizing a variety of particle sizing techniques. Other objectives of this program were to present current information on combustion as well as prepare a replacement for Sections 1.1, 1.2, 1.3, 1.4, 1.6 and 1.7 in EPA report AP-42, "A Compilation of Air Pollutant Emissions Factors."

The above objectives were met by a thorough literature search which included:

- Fine Particle Emissions Inventory System (FPEIS),
- AP-42 background file at EPA's Office of Air Quality Planning and Standards (OAQPS),
- State and local air pollution control agencies, and
- Various industry sources (e.g., American Petroleum Institute, American Boiler Manufacturers Association, Electric Power Research Institute).

The emission data contained in the reference documents were reviewed, analyzed, summarized, and ranked according to the criteria established by OAQPS as published in the EPA report, "Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections," April 1980. After ranking the data, emission factors were calculated using the highest quality data available. The quality of the data used to

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develop each emission factor is indicated by the emission factor rating.

Process control system operating data as well as general industry information were also obtained and summarized as general background information. It was not part of this program to provide detailed engineering analyses, product specifications, or a detailed evaluation of trends in the industry.

Summary of Results

External combustion sources include steam/electric generating plants, industrial boilers, and commercial and domestic combustion units. Coal, fuel oil, and natural gas are the major fossil fuels used by these sources. Other fuels, used in relatively small quantities, are liquefied petroleum gas, wood, coke, refinery gas, blast furnace gas, and other waste or byproduct fuels. Coal, oil, and natural gas currently supply about 95 percent of the total thermal energy consumed in the United States. In 1980 the nation consumed over 530 million Mg (585 million tons) of bituminous coal, nearly 3.6 million Mg (4 million tons) of anthracite coal, 91 x 10^9 liters (24 billion gal.) of distillate oil, 114 x 10^9 liters (37 billion gal.) of residual oil, and 57 x 10^{12} m^3 (20 trillion ft^3) of natural gas.

The primary particulate control devices used for coal combustion include multiple cyclones, electrostatic precipitators (ESPs), fabric filters, and scrubbers. Some measure of control will even result due to ash settling in boiler/air-heater/economizer dust hoppers, large breeches, and chimney bases. For coal-fired units, ESPs are the most common high-efficiency control device used on pulverized-coal and cyclone boilers and are being used increasingly on stoker boilers. Recently, the use of fabric filters has increased in both utility and industrial boiler coal-fired applications. ESPs are commonly used in oil-fired power plants. Some scrubbers have been installed on oil-fired boilers to control both particulate and sulfur oxides. Particulate control equipment is not normally used on natural-gas-fired boilers due to their extremely low particulate loading. Low pressure drop scrubbers, fabric filters, and multicyclones are commonly used for particulate control from wood waste boilers.

The total and size-specific controlled and uncontrolled emission factors for the following external combustion sources are presented in Tables 1 to 16:

Table No.	Combustion Source	Fuel
1	Dry bottom boilers	Pulverized bituminous coal
2	Wet bottom boilers	Pulverized bituminous coal
3	Cyclone furnaces	Bituminous Coal
4	Spreader stokers	Bituminous Coal
5	Overfeed stokers	Bituminous Coal
6	Underfeed stokers	Bituminous Coal
7	Dry bottom boilers	Pulverized anthracite coal
8	Traveling grate stokers	Anthracite coal
9	Utility boilers	Residual oil
10	Industrial boilers	Residual oil
11	Industrial boilers	Distillate oil
12	Commercial boilers	Residual and distillate oil
13	Boilers	Bark
14	Boilers	Wood and bark
15	Boilers	Pulverized lignite
16	Spreader stokers	Lignite

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Table 1. Cumulative Particle Size Distribution and Size Specific Emission Factors For Dry Bottom Boilers Burning Pulverized Bituminous Coal

EMISSION FACTOR RATING C (uncontrolled)
D (scrubber and ESP controlled)
E (multiple cyclone and baghouse)

Particle size (μm)	Cumulative mass % ≤ stated size					Cumulative emission factor[a] (kg/Mg (lb/ton) coal, as fired)				
	Uncontrolled	Controlled				Uncontrolled	Controlled[b]			
		Multiple cyclone	Scrubber	ESP	Baghouse		Multiple cyclone	Scrubber	ESP	Baghouse
15	32	54	81	79	97	1.6A (3.2A)	0.54A (1.08A)	0.24A (0.48A)	0.032A (0.06A)	0.010A (0.02A)
10	23	29	71	67	92	1.15A (2.3A)	0.29A (0.58A)	0.21A (0.42A)	0.027A (0.05A)	0.009A (0.02A)
6	17	14	62	50	77	0.85A (1.7A)	0.14A (0.28A)	0.19A (0.38A)	0.020A (0.04A)	0.008A (0.02A)
2.5	6	3	51	29	53	0.30A (0.6A)	0.03A (0.06A)	0.15A (0.3A)	0.012A (0.02A)	0.005A (0.01A)
1.25	2	1	35	17	31	0.10A (0.2A)	0.01A (0.02A)	0.11A (0.22A)	0.007A (0.01A)	0.003A (0.006A)
1.00	2	1	31	14	25	0.10A (0.2A)	0.01A (0.02A)	0.09A (0.18A)	0.006A (0.01A)	0.003A (0.006A)
0.625	1	1	20	12	14	0.05A (0.10)	0.01A (0.02A)	0.06A (0.12A)	0.005A (0.01A)	0.001A (0.002A)
TOTAL	100	100	100	100	100	5A (10A)	1A (2A)	0.3A (0.6A)	0.04A (0.08A)	0.01A (0.02A)

[a] A = coal ash weight %, as fired
[b] Estimated control efficiency for multiple cyclone, 80%, scrubber, 94%, ESP, 99.2%, baghouse, 99.8%.

Table 2. Cumulative Particle Size Distribution and Size Specific Emission Factors For Wet Bottom Boilers Burning Pulverized Bituminous Coal

EMISSION FACTOR RATING: E

Particle size (μm)	Cumulative mass % ≤ stated size			Cumulative emission factor[a] (kg/Mg (lb/ton) coal, as fired)		
	Uncontrolled	Controlled		Uncontrolled	Controlled[b]	
		Multiple cyclone	ESP		Multiple cyclone	ESP
15	40	99	83	1.4A (2.8A)	0.69A (1.38A)	0.023A (0.046A)
10	37	93	75	1.30A (2.6A)	0.65A (1.3A)	0.021A (0.042A)
6	33	84	63	1.16A (2.32A)	0.59A (1.18A)	0.018A (0.036A)
2.5	21	61	40	0.74A (1.48A)	0.43A (0.86A)	0.011A (0.022A)
1.25	6	31	17	0.21A (0.42A)	0.22A (0.44A)	0.005A (0.01A)
1.00	4	19	8	0.14A (0.28A)	0.13A (0.26A)	0.002A (0.004A)
0.625	2	[c]	[c]	0.07A (0.14A)	[c]	[c]
TOTAL	100	100	100	3.5A (7.0A)	0.7A (1.4A)	0.028A (0.056A)

[a] A = coal ash weight %, as fired
[b] Estimated control efficiency for multiple cyclone, 80%; ESP, 99.2%.
[c] Insufficient data

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Table 3. Cumulative Particle Size Distribution and Size Specific Emission Factors For Cyclone Furnaces Burning Bituminous Coal

EMISSION FACTOR RATING: E

Particle size (μm)	Cumulative mass % ≤ stated size			Cumulative emission factor[a] [kg/Mg (lb/ton) coal, as fired]		
	Uncontrolled	Controlled		Uncontrolled	Controlled[b]	
		Scrubber	ESP		Scrubber	ESP
15	33	95	90	0.33A (0.66A)	0.057A (0.114A)	0.0064A (0.013A)
10	13	94	68	0.13A (0.026A)	0.056A (0.112A)	0.0054A (0.011A)
6	8	93	56	0.08A (0.16A)	0.056A (0.112A)	0.0045A (0.009A)
2.5	0	92	36	0 (0)	0.055A (0.11A)	0.0029A (0.006A)
1.25	0	85	22	0 (0)	0.051A (0.10A)	0.0018A (0.004A)
1.00	0	82	17	0 (0)	0.049A (0.10A)	0.0014A (0.003A)
0.625	0	[c]	[c]	0 (0)	[c]	[c]
TOTAL	100	100	100	1A (2A)	0.06A (0.12A)	0.008A (0.016A)

[a] A = coal ash weight %, as fired.
[b] Estimated control efficiency for scrubber, 94%; ESP, 99.2%.
[c] Insufficient data.

Table 4. Cumulative Particle Size Distribution and Size Specific Emission Factors For Spreader Stroker Burning Bituminous Coal

EMISSION FACTOR RATING: C (uncontrolled and controlled for multiple cyclone without flyash reinjection, and with baghouse)
E (multiple cyclone controlled with flyash reinjection, and ESP controlled)

Particle size (μm)	Cumulative mass % ≤ stated size					Cumulative emission factor[a] [kg/Mg (lb/ton) coal, as fired]				
	Uncontrolled	Controlled				Uncontrolled	Controlled[c]			
		Multiple[a] cyclone	Multiple[b] cyclone	ESP	Baghouse		Multiple[a] cyclone	Multiple[b] cyclone	ESP	Baghouse
15	28	86	74	97	72	8.4 (16.8)	7.3 (14.6)	4.4 (8.8)	0.23 (0.46)	0.043 (0.086)
10	20	73	65	90	60	6.0 (12.0)	6.2 (12.4)	3.9 (7.8)	0.22 (0.44)	0.036 (0.072)
6	14	51	52	82	46	4.2 (8.4)	4.3 (8.6)	3.1 (6.2)	0.20 (0.40)	0.028 (0.056)
2.5	7	8	27	61	26	2.1 (4.2)	0.7 (1.4)	1.6 (3.2)	0.15 (0.30)	0.016 (0.032)
1.25	5	2	16	46	18	1.5 (3.0)	0.2 (0.4)	1.0 (2.0)	0.11 (0.22)	0.011 (0.022)
1.00	5	2	14	41	15	1.5 (3.0)	0.2 (0.4)	0.8 (1.6)	0.10 (0.20)	0.009 (0.018)
0.625	4	1	9	[d]	7	1.2 (2.4)	0.1 (0.2)	0.5 (1.0)	[d]	0.004 (0.008)
TOTAL	100	100	100	100	100	30.0 (60.0)	8.5 (17.0)	6.0 (12.0)	0.24 (0.48)	0.06 (0.12)

[a] With flyash reinjection.
[b] Without flyash reinjection.
[c] Estimated efficiency for ESP, 99.2%; baghouse, 99.8%.
[d] Insufficient data.

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Table 5. Cumulative Particle Size Distribution and Size Specific Emission Factors For Overfeed Stokers Burning Bituminous Coal

EMISSION FACTOR RATING: C (uncontrolled)
E (multiple cyclone controlled)

Particle size (μm)	Cumulative mass % ≤ stated size		Cumulative emission factor [kg/Mg (lb/ton) coal, as fired]	
	Uncontrolled	Multiple cyclone controlled	Uncontrolled	Multiple cyclone controlled[a]
15	49	60	3.9 (7.8)	2.7 (5.4)
10	37	55	3.0 (6.0)	2.5 (5.0)
6	24	49	1.9 (3.8)	2.2 (4.4)
2.5	14	43	1.1 (2.2)	1.9 (3.8)
1.25	13	39	1.0 (2.0)	1.8 (3.6)
1.00	12	39	1.0 (2.0)	1.8 (3.6)
0.625	[b]	16	[b]	0.7 (1.4)
TOTAL	100	100	8.0 (16.0)	4.5 (9.0)

[a] Estimated control efficiency for multiple cyclone, 80%.
[b] Insufficient data.

Table 6. Cumulative Particle Size Distribution and Size Specific Emission Factors For Underfeed Stokers Burning Bituminous Coal

EMISSION FACTOR RATING: C

Particle size (μm)	Cumulative mass % ≤ stated size	Uncontrolled cumulative emission factor[a] [kg/Mg (lb/ton) coal, as fired]
15	50	3.8 (7.6)
10	41	3.1 (6.2)
6	32	2.4 (4.8)
2.5	25	1.9 (3.8)
1.25	22	1.7 (3.4)
1.00	21	1.6 (3.2)
0.625	18	1.4 (2.7)
TOTAL	100	7.5 (15.0)

[a] May also be used for uncontrolled hand-fired units.

Table 7. Cumulative Particle Size Distribution and Size Specific Emission Factors For Dry Bottom Boilers Burning Pulverized Anthracite Coal

EMISSION FACTOR RATING: D

Particle size (μm)	Cumulative mass % ≤ stated size			Cumulative emission factor[a] [kg/Mg (lb/ton) bark, as fired]		
	Uncontrolled	Controlled		Uncontrolled	Controlled[b]	
		Multiple cyclone	Baghouse		Multiple cyclone	Baghouse
15	32	63	79	1.6A (3.2A)	0.63A (1.26A)	0.0079A (0.016A)
10	23	55	67	1.2A (2.3A)	0.55A (1.10A)	0.0067A (0.013A)
6	17	46	51	0.9A (1.7A)	0.46A (0.92A)	0.0051A (0.010A)
2.5	6	24	32	0.3A (0.6A)	0.24A (0.48A)	0.0032A (0.006A)
1.25	2	13	21	0.1A (0.2A)	0.13A (0.26A)	0.0021A (0.004A)
1.00	2	10	18	0.1A (0.2A)	0.10A (0.20A)	0.0018A (0.004A)
0.625	1	7	[c]	0.05A (0.1A)	0.07A (0.14A)	[c]
TOTAL	100	100	100	5A (10A)	1A (2A)	0.01A (0.02A)

[a] A = coal ash weight %, as fired.
[b] Estimated control efficiency for multiple cyclone, 80%; baghouse, 99.8%.
[c] Insufficient data.

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Table 8. Cumulative Particle Size Distribution and Size Specific Emission Factors For Traveling Grate Stokers Burning Anthracite Coal

EMISSION FACTOR RATING: E

Particle size (μm)	Cumulative mass % ≤ stated size	Cumulative emission factor [kg/Mg (lb/ton) coal, as fired]
	Uncontrolled[a]	Uncontrolled
15	64	2.9 (5.8)
10	52	2.4 (4.8)
6	42	1.9 (3.8)
2.5	27	1.2 (2.4)
1.25	24	1.1 (2.2)
1.00	23	1.1 (2.2)
0.625	[b]	[b]
TOTAL	100	4.6 (9.2)

[a] May also be used for uncontrolled hand-fired units.
[b] Insufficient data.

Table 9. Cumulative Particle Size Distribution and Size Specific Emission Factors For Utility Boilers Firing Residual Oil

EMISSION FACTOR RATING: C (uncontrolled)
E (ESP controlled)
D (scrubber controlled)

Particle size (μm)	Cumulative mass % ≤ stated size			Cumulative emission factor[a] [kg/10³l (lb/10³ gal)]		
	Uncontrolled	Controlled		Uncontrolled	Controlled[b]	
		ESP	Scrubber		ESP	Scrubber
15	80	75	100	0.80A (6.7A)	0.0060A (0.05A)	0.06A (0.50A)
10	71	63	100	0.71A (5.9A)	0.0050A (0.042A)	0.06A (0.50A)
6	58	52	100	0.58A (4.8A)	0.0042A (0.035A)	0.06A (0.50A)
2.5	52	41	97	0.52A (4.3A)	0.0033A (0.028A)	0.058A (0.48A)
1.25	43	31	91	0.43A (3.6A)	0.0025A (0.021A)	0.055A (0.46A)
1.00	39	28	84	0.39A (3.3A)	0.0022A (0.018A)	0.050A (0.42A)
0.625	20	10	64	0.20A (1.7A)	0.0008A (0.007A)	0.038A (0.32A)
TOTAL	100	100	100	1A (8.3A)	0.008A (0.067A)	0.06A (0.50A)

[a] Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content:
Grade 6 Oil: A = 1.25(S) + 0.38 Where S is the weight % of sulfur in the oil
Grade 5 Oil: A = 1.25
Grade 4 Oil: A = 0.88
[b] Estimated control efficiency for scrubber, 94%; ESP, 99.2%.

Table 10. Cumulative Particle Size Distribution and Size Specific Emission Factors For Industrial Boilers Firing Residual Oil

EMISSION FACTOR RATING: D (uncontrolled)
E (multiple cyclone controlled)

Particle size (μm)	Cumulative mass % ≤ stated size		Cumulative emission factor[a] [kg/Mg (lb/ton) coal, as fired]	
	Uncontrolled	Multiple cyclone controlled	Uncontrolled	Multiple cyclone controlled[b]
15	91	100	0.91A (7.59A)	0.20A (1.67A)
10	86	95	0.86A (7.17A)	0.19A (1.58A)
6	77	72	0.77A (6.42A)	0.14A (1.17A)
2.5	56	22	0.56A (4.67A)	0.04A (0.33A)
1.25	39	21	0.39A (3.25A)	0.04A (0.33A)
1.00	36	21	0.36A (3.00A)	0.04A (0.33A)
0.625	30	[c]	0.30A (2.50A)	[c]
TOTAL	100	100	1A (8.34A)	0.2A (1.67A)

[a] Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content:
Grade 6 Oil: A = 1.25 (S) + 0.38 Where S is the weight % of sulfur in the oil
Grade 5 Oil: A = 1.25
Grade 4 Oil: A = 0.88
[b] Estimated control efficiency for multiple cyclone, 80%.
[c] Insufficient data.

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Table 11. *Cumulative Particle Size Distribution and Size Specific Emission Factors For Uncontrolled Industrial Boilers Firing Distillate Oil*

EMISSION FACTOR RATING: E

Particle size (μm)	Cumulative mass % ≤ stated size	Cumulative emission factor [kg/10³ l (lb/10³ gal)]
	Uncontrolled	Uncontrolled
15	68	0.16 (1.33)
10	50	0.12 (1.00)
6	30	0.07 (0.58)
2.5	12	0.03 (0.25)
1.25	9	0.02 (0.17)
1.00	8	0.02 (0.17)
0.625	2	0.005 (0.04)
TOTAL	100	0.24 (2.00)

Table 12. *Cumulative Particle Size Distribution and Size Specific Emission Factors For Uncontrolled Commercial Boilers Burning Residual and Distillate Oil*

EMISSION FACTOR RATING: D

Particle size (μm)	Cumulative mass % ≤ stated size		Cumulative emission factor kg/10³ l (lb/10³ gal)	
	Uncontrolled with residual oil	Uncontrolled with distillate oil	Uncontrolled with residual oil[a]	Uncontrolled with distillate oil
15	78	60	0.78A (1.56A)	0.14 (1.17)
10	62	55	0.62A (1.24A)	0.13 (1.08)
6	44	49	0.44A (0.88A)	0.12 (1.00)
2.5	23	42	0.23A (0.46A)	0.10 (0.83)
1.25	16	38	0.16A (0.32A)	0.09 (0.75)
1.00	14	37	0.14A (0.28A)	0.09 (0.75)
0.625	13	35	0.13A (0.26A)	0.08 (0.67)
TOTAL	100	100	1A (2A)	0.24 (2.00)

[a] *Particulate emission factors for residual oil combustion without emission controls are, on average, a function of fuel oil grade and sulfur content:*
Grade 6 Oil: A = 1.25(S) + 0.38 Where S is the weight % of sulfur in the oil
Grade 5 Oil: A = 1.25
Grade 4 Oil: A = 0.88

Table 13. *Cumulative Particle Size Distribution and Size Specific Emission Factors For Bark Fired Boilers*

EMISSION FACTOR RATING: D

Particle size (μm)	Cumulative mass % ≤ stated size				Cumulative emission factor [kg/Mg (lb/ton) bark, as fired]			
	Uncontrolled	Controlled			Uncontrolled	Controlled		
		Multiple cyclone[a]	Multiple cyclone[b]	Scrubber[c]		Multiple cyclone[a]	Multiple cyclone[b]	Scrubber[c]
15	42	90	40	92	10.1 (20.2)	6.3 (12.6)	1.8 (3.6)	1.32 (2.64)
10	35	79	36	87	8.4 (16.8)	5.5 (11.0)	1.62 (3.24)	1.25 (2.50)
6	28	64	30	78	6.7 (13.4)	4.5 (9.0)	1.35 (2.7)	1.12 (2.24)
2.5	21	40	19	56	5.0 (10.0)	2.8 (5.6)	0.86 (1.72)	0.81 (1.62)
1.25	15	26	14	29	3.6 (7.2)	1.8 (3.6)	0.63 (1.26)	0.42 (0.84)
1.00	13	21	11	23	3.1 (6.2)	1.5 (3.0)	0.5 (1.0)	0.33 (0.66)
0.625	9	15	8	1·	2.2 (4.4)	1.1 (2.2)	0.36 (0.72)	0.20 (0.40)
TOTAL	100	100	100	100	24 (48)	7 (14)	4.5 (9.0)	1.44 (2.88)

[a] *With flyash reinjection.*
[b] *Without flyash reinjection.*
[c] *Estimated control efficiency for scrubber, 94%.*

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Table 14. Cumulative Particle Size Distribution and Size Specific Emission Factors For Wood/Bark Fired Boilers

EMISSION FACTOR RATING: E (A for dry electrostatic granular filter [DEGF])

Particle size (μm)	Cumulative mass % ≤ stated size					Cumulative emission factors [kg/Mg (lb/ton) wood/bark, as fired]				
	Uncontrolled[a]	Controlled				Uncontrolled[a]	Controlled			
		Multiple cyclone[b]	Multiple cyclone[c]	Scrubber[d]	DEGF[b]		Multiple cyclone[b]	Multiple cyclone[c]	Scrubber[d]	DEGF[b]
15	94	96	35	98	77	3.38 (6.77)	2.88 (5.76)	0.95 (1.90)	0.216 (0.431)	0.123 (0.246)
10	90	91	32	98	74	3.24 (6.48)	2.73 (5.46)	0.86 (1.72)	0.216 (0.432)	0.118 (0.236)
6	86	80	27	98	69	3.10 (6.20)	2.40 (4.80)	0.73 (1.46)	0.216 (0.432)	0.110 (0.220)
2.5	76	54	16	98	65	2.74 (5.47)	1.62 (3.24)	0.43 (0.86)	0.216 (0.432)	0.104 (0.208)
1.25	69	30	8	96	61	2.48 (4.97)	0.90 (1.80)	0.22 (0.44)	0.211 (0.422)	0.098 (0.196)
1.00	67	24	6	95	58	2.41 (4.82)	0.72 (1.44)	0.16 (0.32)	0.209 (0.418)	0.093 (0.186)
0.625	[e]	16	3	[e]	51	[e]	0.48 (0.96)	0.081 (0.162)	[e]	0.082 (0.164)
TOTAL	100	100	100	100	100	3.6 (7.2)	3.0 (6.0)	2.7 (5.4)	0.22 (0.44)	0.16 (0.32)

[a] From data on underfeed stokers. May also be used as size distribution for wood fired boilers.
[b] From data on spreader stokers. With flyash reinjection.
[c] From data on spreader stokers. Without flyash reinjection.
[d] From data on dutch ovens. Estimated control efficiency, 94%.
[e] Insufficient data.

Table 15. Cumulative Particle Size Distribution and Size Specific Emission Factors For Boilers Burning Pulverized Lignite Coal

EMISSION FACTOR RATING: E

Particle size (μm)	Cumulative mass % ≤ stated size		Cumulative emission factor[a] [kg/Mg (lb/ton) coal, as fired]	
	Uncontrolled	Multiple cyclone controlled	Uncontrolled	Multiple cyclone controlled[b]
15	51	77	1.58A (3.16A)	0.477A (0.954A)
10	35	67	1.09A (2.18A)	0.415A (0.830A)
6	26	57	0.81A (1.62A)	0.353A (0.706A)
2.5	10	27	0.31A (0.62A)	0.167A (0.334A)
1.25	7	16	0.22A (0.44A)	0.099A (0.198A)
1.00	6	14	0.19A (0.38A)	0.087A (0.174A)
0.625	3	8	0.09A (0.18A)	0.050A (0.100A)
TOTAL	100	100	3.1A (6.2A)	0.62A (1.24A)

[a] A = coal ash weight % content, as fired.
[b] Estimated control efficiency for multiple cyclone, 80%.

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Table 16. Cumulative Particle Size Distribution and Size Specific Emission Factors For Lignite Fueled Spreader Stokers

EMISSION FACTOR RATING: E

Particle size (μm)	Cumulative mass % ≤ stated size		Cumulative emission factor[a] [kg/Mg (lb/ton) coal, as fired]	
	Uncontrolled	Multiple cyclone controlled	Uncontrolled	Multiple cyclone controlled[b]
15	28	55	0.95A (1.9A)	0.374A (0.748A)
10	20	41	0.68A (1.36A)	0.279A (0.558A)
6	14	31	0.48A (0.96A)	0.211A (0.422A)
2.5	7	26	0.24A (0.48A)	0.177A (0.354A)
1.25	5	23	0.17A (0.34A)	0.156A (0.312A)
1.00	5	22	0.17A (0.34A)	0.150A (0.300A)
0.625	4	[c]	0.14A (0.28A)	[c]
TOTAL	100	100	3.4A (6.8A)	0.68A (1.36A)

[a] Coal ash weight % content, as fired.
[b] Estimated control efficiency for multiple cyclone, 80%.
[c] Insufficient data.

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The complete report, entitled "External Combustion Particulate Emissions: Source Category Report," (Order No. PB 87-140 901/AS; Cost: $24.95, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
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